New Discovery Could Lead to Better Plastics

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In the late 1960s, the memorable advice given to a certain graduate of movie fame was to go into plastics. Forty years later, Caltech chemical engineering professor Julia Kornfield would like to add the word "shish-kebabs."

Shish-kebabs are beautiful, tiny structures that can form when polymers crystallize during flow. When magnified a million times they resemble a skewer running through a stack of bell peppers. Inside plastics, they make car body panels stiff and carpet fibers strong.

Shish-kebabs are responsible for the product's nice glossy finish and the hardness, but they are not without their problems. They might help you to resist a scratch, but they might also cause a layer to peel off. And that's why people want to control them.

Now, Kornfield and Yoshinobu Nozue at Sumitomo have led a team that has uncovered certain properties of shish-kebabs that should lead to improved materials in the most widely used plastics. The researchers are reporting their results in the May 18 issue of the journal *Science*.

"Our discovery is pertinent to the relatively strong and stiff plastics," says Kornfield. "For example, it will allow manufacturers to make polymers for complex and beautifully shaped body panels with equal or better quality than currently available-and cheaper and faster."

Shish-kebabs are made of polymers known as polyolefins, which make up half of all plastics used-over 100 million tons per year. In addition to

being used for car parts, polyolefins are also used to make pipes, wire, cable, carpets, fabrics, disposable syringes, and many other things.

Polyolefins are useful because manufacturers can custom-design their properties, Kornfield explains. By varying the degree of crystallinity and the way the crystals come together, polyolefins can be altered so that they are as hard as steel or as soft as a rubber band.

"The plastics industry can tailor-make molecular distributions, but we don't know how to manipulate them," Kornfield explains. "This discovery opens up a whole new neck of the woods that people didn't know they could explore, and they'll be able to create combinations of properties you couldn't get before."

Much as an inspiring leader can influence the action of thousands, the researchers discovered, some molecules (especially long ones) can marshal many others to create the shish, which then direct the formation of kebabs. This knowledge will allow for greater control of the creation process itself.

"In other words, you could make things by injection molding that you couldn't make before, and injection molding is a very cheap, fast process- you can pop a plastic bumper for an automobile out of its mold in a couple of minutes. So you bring down the cost of manufacturing and at the same time increase the throughput."

The lead author of the paper is Shuichi Kimata, a former postdoctoral researcher in Kornfield's Caltech lab. He played a central role linking Kornfield's group at Caltech with Yoshinobu Nozue's group at Sumitomo and collaborators at the University of Tokyo.

The title of the *Science* paper is "Molecular Basis of the Shish-Kebab Morphology in Polymer Crystallization."

Source: Caltech